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Preservation of Pomegranate Arils in Syrup and Its Quality Evaluation during Storage

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ABSTRACT

Studies undertaken to prepare arils-in-syrup product and its quality evaluation during storage are reported here. Out of seven combinations of arils and syrup the product with 50 per cent arils and 50 per cent syrup of 70° Brix was adjudged to be the best on the basis of its sensory characteristics. It could safely be stored for a period of six months under refrigerated storage conditions without much changes in various quality characteristics. However, acidity decreased from 0.82 to 0.66 %, pH increased from 3.50 to 3.66%, TSS increased from 37.50 to 44.30° Brix, total sugars increased from 31.88 to 37.66%, ascorbic acid decreased from 9.23 to 5.13 mg/100g, and antioxidant activity decreased from 63.23 to 49.06 % during storage. Both the packaging materials viz., PET and glass jars were found suitable, with comparatively less changes occurring in glass jar.

Key words: *Pomegranate, corn syrup, Sucrose syrup, Glass jar and PET jar*

INTRODUCTION

Pomegranate (*Punica granatum)* belonging to the family Punicaceae is an ancient favourite table-fruit of the tropical and sub-tropical regions of the world. The word pomegranate is derived from pomum (fruit) and granates (seeded). Locally pomegranate is known as *Dhalimbe*. Morphologically it is known as Balusta. Pomegranate is native to Iran and is widely cultivated throughout India. As a commercial crop, pomegranate is grown on a large scale in Maharashtra, Karnataka, Andhra Pradesh, Uttar Pradesh, Gujarat, Rajasthan and Tamil Nadu. In the world it is also grown in Burma, China, Japan and USA[17].

The edible part of this fruit is a rich source of organic acids apart from having appreciable amount of sugars, anthocyanins, phenols, ascorbic acid etc. Arils of this fruit also contain good amount of minerals like phosphorus, calcium, potassium and iron[15].

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This fruit is a rich source of citric acid, besides other acids like malic, succinic and tartaric acid[18]. It has various medicinal properties like laxative, diuretic and is used for curing vomiting, sore throat, brain diseases, spleen complaints, chest troubles, scabies, bronchitis, earache, liver and kidney disorders[8]. The cultivated fruit has cancer fighting properties and a glass full of pomegranate juice is said to contains more antioxidants than 10 cups of green tea[1].

There are several techniques of preservation or processing available for different fruits. Preservation of pomegranate arils in sugar syrup helps to improve flavour, retaining texture and to preserve the natural color and shape. Through osmosis, sugar replaces some of the water in the fruit. This natural process preserves the inherent color, texture and shape of arils. In addition, sugar upon entering the cells, helps to minimize oxidation and prevents the firm texture from becoming mushy[2]. It is a paradox that such a miracle fruit having enormous potential for therapeutic use has never been utilized for value addition except in the form of beverages. Therefore, the attempts were made in the present investigation to develop arils in syrup product and to study its storage life.

MATERIAL AND METHODS

Raw materials

Fresh pomegranate fruits (var. Kesar) used in research were purchased from Kaladagi, a place known for production of pomegranate. High maltose corn syrup was procured from Amingad Agencies, Dharwad. Packaging materials like PET bottles and glass bottles were procured from local market.

Treatment details

Treatments	Syrup (%)	Arils (%)	Citric acid (%)
T_1	70 % **[**Sucrose + Corn syrup (1:1)]	30	1
T_2	60 % **[**Sucrose + Corn syrup (1:1)]	40	1
T_3	50 % **[**Sucrose + Corn syrup (1:1)]	50	1
T_4	40 % **[**Sucrose + Corn syrup (1:1)]	60	1
T_5	30 % **[**Sucrose + Corn syrup (1:1)]	70	1
T_6 (Control-1)	50 % Corn syrup	50	1
T_7 (Control-2)	50 % Sucrose syrup	50	1

Syrup preparation

Syrup was prepared by blending high maltose corn syrup (70º brix) and sucrose syrup (70º brix) in the ratio of 1:1 (Fig. 1).

Packaging and storage

The arils in syrup product was prepared packed in glass and PET jars of each of 200 ml capacity. Packed product was stored in refrigerated conditions for 6 months. The physico-chemical and microbiological quality characteristics of the product were carried out at 0, 2, 4 and 6 months of storage.

Sensory evaluation

Sensory evaluation of pomegranate arils in syrup was carried out by 15 semi trained panel consisting of Teachers and Post-Graduate students of College of Horticulture, Bagalkot with the help of nine point hedonic rating scale (1 = dislike extremely, 2 = like only slightly, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) for colour, falvour, taste, consistency and overall acceptability[19] (Swaminathan, 1974). The products along with control samples (T_6 and T_7) were coded and served randomly to the panelist for sensory evaluation.

The best treatment from sensory evaluation was taken for storage studies.

Analysis

The product was analyzed for different quality attributes. Titratable acidity was measured by titrating a known volume of the sample against

standard NaOH solution by using phenolphthalein as an indicator and expressed as per cent citric acid. The pH of the product was determined by using a digital pH meter having combined electrode as described by Jackson[5]. TSS of samples were measured by using 'Erma' make hand refractometer and expressed as ºbrix after making necessary temperature corrections to the recorded readings. Total sugars were estimated by anthrone reagent method. Ascorbic acid content was determined as per AOAC method using 2, 6-dichlorophenol indophenol dye. The percentage of 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of the arils in syrup was determined by a method described by Eghdami and Asli[3]. Microbial quality of pomegranate arils in syrup during storage was estimated by serial dilution technique using total plate count/standard plate count agar medium prepared according to Ranganna[16].

Microbial quality evaluation

Total plate count was estimated by serial dilution technique using total plate count/standard plate count agar medium prepared according to Ranganna[16]. The inoculated plates were then incubated at 37°C for 72 h prior to counting of microbes. The results of the total plate count (TPC) were expressed as cfu/g of sample.

Statistical analysis

The data on sensory evaluation of pomegranate arils in syrup was analyzed by completely randomized design (CRD) and data of storage studies were subjected to factorial completely randomized design (FCRD) analysis. Interpretation of data was carried out in accordance with Panse and Sukhatme[14] (1985). The level of significance used in 'F' and 't' test was p=0.01. Critical difference values were calculated whenever 'F' test was found significant.

RESULTS AND DISCUSSION

Sensory characteristics

Colour is the important parameter which decides the consumer preference. It was found to be significantly highest (7.62) in T_7 (50% sucrose syrup + 50% arils). The highest score for colour in sugar syrup may be due to attractive bright colour of pomegranate arils in sugar syrup, which is more translucent than those preserved in corn syrup. Corn syrup is slightly opaque due to thick consistency and thus it is less translucent than sucrose. Flavour is the combined perception of taste, aroma and mouthfeel (Benoit, 2004). Higher score for flavour (7.19) was recorded in the treatment T_3 [50% sucrose + corn syrup (1:1) + 50% arils]. The taste of the pomegranate arils in syrup was scored maximum in T_3 [50% sucrose + corn syrup (1:1) + 50% arils] and T_7 (50 % sucrose syrup + 50% arils) (7.04 each). Highest score for consistency was observed in treatment T_3 [50% sucrose + corn syrup (1:1) + 50% arils] and T_6 (50% Corn syrup + 50% arils) (7.23 each). Highest score for overall acceptability was observed in treatment T_3 (7.21) with the combination of 50 per cent of arils in 50 per cent of sucrose and corn syrup (1:1). This may be due to highest score for flavour, taste and consistency in comparison with the other treatments (Table 1). The results obtained are in conformity with the results of Thakur *et al*[20]., in wild pomegranate arils in 50 % syrup.

Biochemical quality evaluation during storage

Out of 7 treatments, best treatment with highest average sensory score (colour, flavour, taste, consistency and overall acceptability) from the 1st experiment was further evaluated at bimonthly interval for their bio-chemical qualities over a period of 6 months. The best treatment of pomegranate arils in syrup selected for further study was T_3 [50% syrup (Sucrose + Corn syrup (1 :1) -70º brix) + 50% arils + 1% citric acid) (Table 1). The results of this study are discussed below.

Titrable acidity and pH:

The highest titrable acidity (0.77%) of pomegranate arils in syrup was recorded in the packing material P_1 (Glass jar) and it was statistically different with P_2 (0.72%) (PET jar). The titrable acidity decreased significantly during storage in both the packing materials (Table 2). The decrease in the titrable acidity of the pomegranate arils in

syrup could be attributed to chemical interaction between organic constituents of the arils and syrup induced by temperature and action of enzymes as observed by Palaniswamy and Muttukrishnan[13] and Nath *et al*[12]., and this might also be due to hydrolysis of polysaccharides.

Irrespective of the storage periods, the mean pH of the pomegranate arils in syrup stored in packing materials was 3.60 and 3.61 in glass jar and PET jar, respectively. Both the packing materials with respect to pH were statistically similar with each other (Table 2). There was an increase in the pH of pomegranate arils in syrup in both the packing materials with advancement in storage period. This was indicated by the mean pH of pomegranate arils in syrup exhibited variation from 3.50 (initial) to 3.66 (6 MAS). This rise in pH and decrease in titrable acidity during storage period indicates the opposite relation existing between pH and acidity. Retention of more titrable acidity and less pH of arils with syrup in glass jar may be due to the slower reaction rate in glass jar than compared to PET jar.

Total soluble solids and total sugars:

Total soluble solids (TSS) content was highest (41.57º brix) in P_2 (PET jar) and it was on par with P_1 (Glass jar) (Table 3). During the storage periods of six months, there was a significant increase in total soluble solids (37.50 to 44.30º brix) and total sugars (31.88 to 37.66%) of pomegranate arils in syrup. The maximum TSS content (44.54º brix) and the maximum total sugar content (37.86%) was recorded in P_2 at the end of 6 MAS.

Between the packing materials, highest total sugar content (35.37%) was found in P_2 (PET jar). The increase in TSS and total sugars could be attributed to slow hydrolysis of starch into sugars might have resulted in production of soluble compounds particularly the sugars[4]. Similar trend of increase in sugars have been reported by Waskar and Khurdiya[21] in phalsa syrup and Jadhav *et al*[6]., in kokum syrup. As far as the packaging material is concerned, higher increase in total sugars recorded in arils with syrup packed in PET jar as compared to glass jar might be due to faster rate of chemical reactions of the product packed in PET jar as a result of difference in thermal conductance properties. Similar findings were also reported by Thakur *et al*[20]., in wild pomegranate arils in syrup.

Ascorbic acid and antioxidant activity:

Ascorbic acid is one of the important components of the product from nutritional point of view. The mean ascorbic acid content of the packing materials irrespective of storage period was 7.23 mg per 100 g (P_1) and 6.67 mg per 100 g (P_2). The ascorbic acid (vitamin 'C') content of the pomegranate arils in syrup decreased during storage in both the packing materials with the advancement of storage period (Fig. 2). This may probably be due to the fact that ascorbic acid being sensitive to oxygen, light and heat was easily oxidized in presence of oxygen by both enzymatic and non-enzymatic catalyst[10]. Decrease in ascorbic acid content during storage might be due to its degradation into dehydro-ascorbic acid or furfural as described by Kotecha and Kadam[9] in tamarind syrup. Lower decrease in ascorbic acid of arils in syrup packed in glass jar observed during storage might be due to the slower rate of reactions in glass jar as glass materials absorb heat slower than PET material.

Highest antioxidant activity (57.23%) was recorded in P_1 (Glass jar) followed by P_2 (PET jar). There was a continuous decrease in the antioxidant activity with advancement of storage period (Table 4). Decrease in the antioxidant activity may be linked to lower content of vitamin C in stored arils as compared to fresh ones. Irrespective of the packing materials, highest antioxidant activity was recorded at initial period (63.23%) and the least at 6 MAS (49.06%) (Fig.3). However, more antioxidant activity of pomegranate arils in syrup in glass jar could be due to maximum retention of vitamin C and also the slower reaction rate in glass jar, as glass material absorbs heat at slower rate as compared to PET. The results of the study are in accordance with the study of Yadla and

Sachdev[22] who reported that, minimum decrease in antioxidant activity was noticed in tomato salsa packed in glass jars stored at refrigeration temperature followed by cans and retort pouches during four months of storage studies.

Microbial quality (Total plate count):

The minimum microbial count of 10 cfu/g was observed in glass jar after six months. Increase in total microbial count (cfu/g) was observed during storage (Table 5), which might be due to contamination during plating instead of contaminated product. The arils in syrup packed in glass jar recorded minimum microbial load during storage. Muzzaffar[11] in pumpkin products and Kaushal[7] in seabuckthorn appetizer have also reported a low microbial count at initial stage which increased slightly during storage. Except for this increase in microbial count no other visual spoilage symptoms like fermentation, discolouration and gas formation etc. were observed in arils in syrup which confirm that product was safe for consumption.

Table 1: Sensory evaluation of product of pomegranate arils in sugar and corn syrup

Treatments	Colour *	Flavour *	Taste *	Texture/ Consistency *	Overall acceptability *	Average	Rank
T_1	6.92	6.64	6.77	6.69	6.85	6.77	7
T_2	7.31	6.96	6.92	6.81	7.13	7.03	4
T_3	7.54	7.19	7.04	7.23	7.21	7.24	1
T_4	7.54	6.77	7.00	6.77	7.15	7.05	3
T_5	7.46	6.85	6.92	6.77	6.96	6.99	5
T_6	6.54	6.81	6.77	7.23	7.12	6.89	6
T_7	7.62	6.58	7.04	7.15	7.19	7.12	2
SEm±	**0.28**	**0.25**	**0.28**	**0.31**	**0.26**		
CD (1%)	**NS**	**NS**	**NS**	**NS**	**NS**		

NS: Non-significant

Table 2: Effect of packing materials and storage period on titrable acidity and pH of pomegranate arils in syrup

Treatments	Titrable acidity (%)					pH				
	S_1 (Initial)	S_2 (2MAS)	S_3 (4MAS)	S_4 (6MAS)	Mean	S_1 (Initial)	S_2 (2MAS)	S_3 (4MAS)	S_4 (6MAS)	Mean
P_1 - Glass jar	0.82	0.78	0.77	0.69	**0.77**	3.50	3.64	3.63	3.65	**3.60**
P_2 - PET jar	0.82	0.75	0.67	0.63	**0.72**	3.50	3.61	3.66	3.67	**3.61**
Mean	**0.82**	**0.77**	**0.72**	**0.66**		**3.50**	**3.63**	**3.64**	**3.66**	
	SEm±		**CD (1%)**			**SEm±**		**CD (1%)**		
Packing material	0.01		0.04			0.01		NS		
Storage period	0.02		0.06			0.02		0.07		
Interaction (PxS)	0.02		NS			0.03		NS		

MAS= Months after storage NS=Non significant

Table 3: Effect of packing materials and storage period on total soluble solids and total sugars of pomegranate arils in syrup

Treatments	Total soluble solids (° Brix)					Total sugars (%)				
	S_1 (Initial)	S_2 (2MAS)	S_3 (4MAS)	S_4 (6MAS)	Mean	S_1 (Initial)	S_2 (2MAS)	S_3 (4MAS)	S_4 (6MAS)	Mean
P_1 - Glass jar	37.50	40.18	43.74	44.06	**41.41**	31.88	34.15	37.18	37.45	**35.16**
P_2 - PET jar	37.50	40.34	44.06	44.54	**41.57**	31.88	34.29	37.45	37.86	**35.37**
Mean	**37.50**	**40.26**	**43.90**	**44.30**		**31.88**	**34.22**	**37.32**	**37.66**	
	SEm±		**CD (1%)**			**SEm±**		**CD (1%)**		
Packing material	0.33		NS			0.28		NS		
Storage period	0.47		1.84			0.40		1.56		
Interaction (PxS)	0.67		NS			0.57		NS		

MAS= Months after storage NS=Non significant

Table 4: Effect of packing materials and storage period on ascorbic acid and antioxidant activity of pomegranate arils in syrup

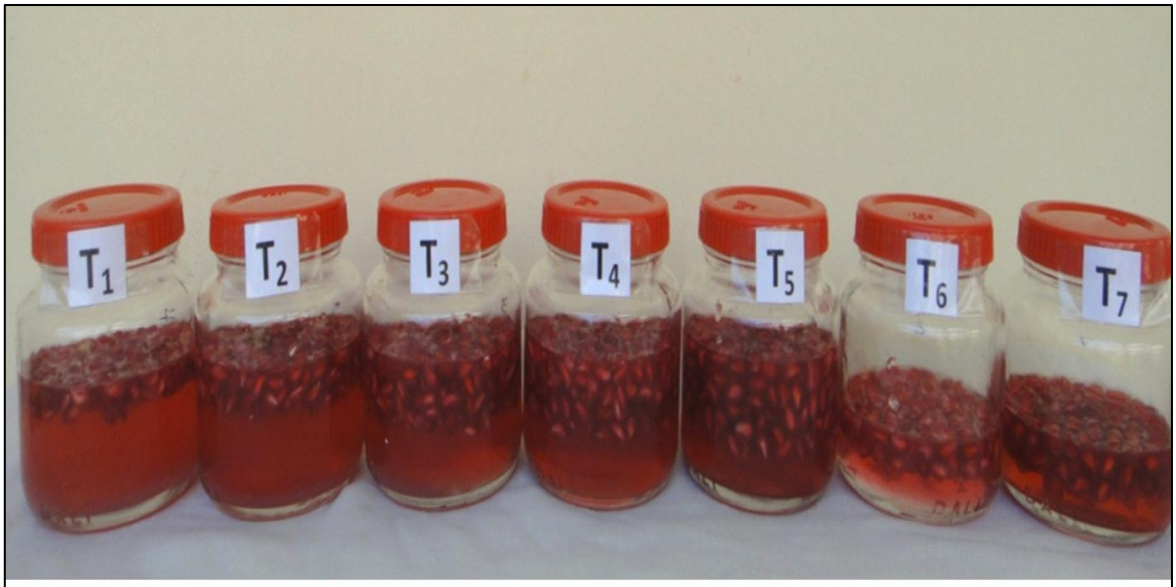
Treatments	Ascorbic acid (mg/100 g)					Antioxidant activity (%)				
	S_1 (Initial)	S_2 (2MAS)	S_3 (4MAS)	S_4 (6MAS)	Mean	S_1 (Initial)	S_2 (2MAS)	S_3 (4MAS)	S_4 (6MAS)	Mean
P_1 - Glass jar	9.23	7.59	6.56	5.54	**7.23**	63.23	59.34	55.19	51.16	**57.23**
P_2 - PET jar	9.23	6.97	5.74	4.72	**6.67**	63.23	57.45	53.57	46.96	**55.30**
Mean	**9.23**	**7.28**	**6.15**	**5.13**		**63.23**	**58.40**	**54.38**	**49.06**	
	SEm±		**CD (1%)**			**SEm±**		**CD (1%)**		
Packing material	0.11		0.44			0.24		0.94		
Storage period	0.16		0.62			0.34		1.33		
Interaction (PxS)	0.23		NS			0.48		1.88		

MAS= Months after storage NS=Non significant

Table 5: Effect of packing materials and storage period on microbial population (cfu/g) of pomegranate arils in syrup

Treatments	Microbial population (cfu/g)			
	S_1 (Initial)	S_2 (2MAS)	S_3 (4MAS)	S_4 (6MAS)
P_1 - Glass jar	00	01	03	10
P_2 - PET jar	00	02	06	30

MAS= Months after storage



T_1 - 70% Sucrose + Corn syrup (1:1) + 30% Arils
T_2 - 60% Sucrose + Corn syrup (1:1) + 40% Arils
T_3 - 50% Sucrose + Corn syrup (1:1) + 50% Arils
T_4 - 40% Sucrose + Corn syrup (1:1) + 60% Arils
T_5 - 30% Sucrose + Corn syrup (1:1) + 70% Arils
T_6 - 50% Corn syrup + 50% Arils
T_7 - 50% Sucrose syrup + 50% Arils

Fig. 1: Short term preservation product of pomegranate arils in syrup

CONCLUSION

The arils in syrup product prepared by blending 50 per cent arils in 50 per cent syrup (sucrose and corn syrup (1:1)) with one per cent citric acid was found to be the best on the basis of its sensory parameters. This product could be stored better for a period of six months under refrigerated condition in a glass bottle as compared to PET jars.

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