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Research Paper

Development of wild pomegranate aril-in-syrup and its quality evaluation during storage

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Abstract

Studies undertaken to prepare arils-in-syrup product from wild pomegranate and its quality evaluation during storage are reported here. Out of ten combinations of arils, syrup and TSS of syrup the product with 40 per cent arils and 60 per cent syrup of 75^0B was adjudged to be the best on the basis of its sensory and some physico-chemical characteristics like colour, titratable acidity, ascorbic acid. It could safely be stored for a period of six months under both the ambient and refrigerated storage conditions without much changes in various quality characteristics. However, Sugars increased from 36.77 to 41.52% ,ascorbic acid decreased from 8.34 to 4.99mg/100g, anthocyanins decreased from 8.09 to 3.15 mg/100g, phenols decreased from 32.91 to 25.75% during storage. Changes in the quality characteristics of the product were slower in refrigerated storage conditions than ambient. Both the packaging materials viz., PET and glass jars were found suitable, with comparatively less changes occurring in glass jar under refrigerated conditions.

Keywords: Wild pomegranate, *Punica granatum*, arils-in-syrup, Polyethylene terephthalate

Introduction

Wild pomegranate (*Punica granatum* L.) is one of the most important wild fruit, which resembles cultivated pomegranate for various morphological characters (Sharma and Sharma, 1990). In India, it is found in vast tract of the hill slopes of Himachal Pradesh, Jammu and Kashmir and Uttrakhand at an altitude of 900 to 1800 m above mean sea level. In Himachal Pradesh, it is found in some areas of Solan, Sirmour, Mandi, Shimla, Kullu and Chamba districts (Bhrot, 1998).

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 (Parmar and Kaushal, 1982). This fruit is a rich source of citric acid , besides other acids like malic, succinic and tartaric acid (Saxena *et al*., 1987). 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 (Kirtikar and Basu, 1935). 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 (Anon, 2005).

Wild pomegranate is too acidic by nature that is why it cannot be used for table purpose but is being used as a good souring agent in curries, chutneys and other culinary preparations in dried form (Phadnis, 1974). It is a paradox that such a miracle fruit having enormous potential for therapeutic use has never been utilized commercially for

value addition except in the form of *anardana* at traditional level. An important reason for this is lack of awareness its nutritive value, use and most importantly unavailability of technology for its processing. Keeping in view all these factors, the present studies were under taken to develop arils in syrup product from this fruit and study its storage life.

Material and Methods

Raw materials

Wild pomegranate fruits harvested at optimum maturity were procured from Narag area of Sirmour district of Himachal Pradesh, India and were brought to the department of Food Science and Technology Nauni, Solan, HP. Fruits after thorough washing in water were used for physico-chemical analysis and arils extraction. Packaging materials like PET bottles and glass bottles were procured from local market.

Arils extraction and development of product

Freshly extracted arils were steam blanched for 30 seconds as per the procedure described by Thakur et al (2010). These blanched arils were then put in the sugar syrup of different concentrations (70, 75^{0}B). Arils and syrup were mixed together in different proportions as given in the Table 1. Sodium benzoate (600 ppm) was added to all the treatment combinations as a preservative during the preparation of this product. For physico-chemical analysis of this product a mixture of equal amount of both arils and syrup was taken.

Table 1: Treatment details of arils in syrup

TreatmentSymbol	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
Syrup (%)	70	60	50	40	30	70	60	50	40	30
Arils (%)	30	40	50	60	70	30	40	50	60	70
TSS (^{0}B)	75	75	75	75	75	70	70	70	70	70

Packaging and storage

The arils in syrup product was prepared by following the best recipe (Fig1) and was packed in pre-sterilized glass and PET jars of each of 200 ml capacity. Packed product was stored both at ambient (20-25^{0}C) and low temperature (4-7^{0}C) conditions for 6 months. The physico-chemical, microbiological and sensory quality characteristics of the product were carried out at 0, 3 and 6 months of storage.

Fruit Selection
↓
Washing
↓
Cutting into parts
↓
Extraction of arils
↓
Steam blanching (30 s)
↓
Dipping of arils in syrup (60% Syrup of 75^{0}B and 40% Arils)
↓ + Sodium benzoate (600 ppm)
Filling in Jars
↓
Capping
↓
Labelling
↓
Storage

Fig. 1: Unit operations for the preparation of arils in syrup from wild pomegranate

Analysis

Wild pomegranate fruit product was analyzed for different quality attributes. The colour of arils in syrup in terms of colour card number was compared with the colour card of Royal Horticultural society of London.. 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 (AOAC, 1984). The pH of the drink was determined by using a digital pH meter (CRISON Instrument, Ltd, Spain). TSS of samples were measured by hand refractometer and results were expressed as ^{0}Brix. Sugars were estimated as per the standard procedure given by Ranganna (1997). Ascorbic acid content was determined as per AOAC (1984) method using 2, 6-dichlorophenol indophenol dye. Total anthocyanins present in all the samples were determined by a‘ method given by Ranganna (1997). The phenols or tannin contents were determined by the Folin- Ciocalteu procedure of Singleton and Rossi (1965).

Sensory evaluation

Nine points hedonic rating test (Amerine *et al.* 1965, Joshi,2006) was followed for conducting the sensory

evaluation of wild pomegranate arils in syrup product. A panel of ten judges comprising of faculty members and postgraduate students were selected to evaluate the products for sensory parameters such as colour, texture , taste, aroma and overall acceptability. Efforts were made to keep the same panel for sensory evaluation throughout the entire period of study.

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 (1997). The innoculated plates were then incubated at 37^0C for 72 h prior to counting of microbes. The results of the total plate count (TPC) were expressed as x 10^2 cfu/g of sample.

Statistical analysis

Data on physico-chemical characteristics of the product was analysed by Completely Randomized Design (CRD) before and during storage, whereas, data pertaining to the sensory evaluation were analyzed by using Randomized Block Design (RBD) as described by Mahony (1985). The experiment for recipe standardization was replicated three times and for storage studies five times.

Results and Discussion

Physico-chemical and sensory characteristics:

Data (Table 2) pertaining to physico-chemical characteristics of different recipes of this product showed that the visual colour of the product in all recipes was observed red purple 61 (C). The maximum titratable acidity of the product was noted in T_{10} which was statistically at par with T_5, however, minimum titratable acidity was recorded in T_1 and T_6. The ascorbic acid content of the product varied from 6.67 to 14.15 mg/100 g, highest value was observed in T_5, whereas, lowest in T_6. The pH values of the product ranged between 3.18 to 3.95 and highest was observed in T_1 and T_6 and lowest in T_{10}. Data in the Table 3 reveal that the colour , texture, taste, aroma and overall acceptability scores of the product were obtained higher in T_2 as compared to other treatments.

Table 2. Physico-chemical characteristics of different recipes of wild pomegranate arils in syrup

Treatments	Physico-chemical characteristics				
	Colour	TSS(^{0}B)	Titratableacidity(%)	AscorbicAcid(mg/100 g)	pH
T_1	Red Purple61 (C)	60	1.08	6.69	3.95
T_2	Red Purple61 (C)	60	1.40	8.34	3.80
T_3	Red Purple61 (C)	60	1.75	10.74	3.61
T_4	Red Purple61 (C)	60	2.27	12.77	3.44
T_5	Red Purple61 (C)	60	2.63	14.15	3.21
T_6	Red Purple61 (C)	55	1.08	6.67	3.95
T_7	Red Purple61 (C)	55	1.39	8.49	3.82
T_8	Red Purple61 (C)	55	1.80	11.85	3.63
T_9	Red Purple61 (C)	55	2.30	12.77	3.39
T_{10}	Red Purple61 (C)	55	2.64	14.12	3.18
$CD_{0.05}$	-	-	0.25	0.95	0.22

Table 3. Sensory characteristics (score) of different recipes of wild pomegranate arils in syrup

Treatment	Colour	Texture	Taste	Aroma	Overall acceptability
T_1	7.65	7.80	7.20	7.50	7.00
T_2	8.15	8.20	8.60	8.40	8.25
T_3	7.70	7.75	7.00	7.40	7.25
T_4	7.90	7.00	6.25	6.65	6.55
T_5	7.95	6.80	5.00	6.00	5.20
T_6	7.70	7.60	7.00	7.30	6.85
T_7	8.25	8.00	8.00	7.80	7.50
T_8	7.80	7.65	6.80	7.25	7.00
T_9	8.00	7.15	6.00	6.50	6.10
T_{10}	8.00	6.60	5.70	5.10	5.25
$CD_{0.05}$	0.14	0.21	0.48	0.54	0.62

While going through the results of wild pomegranate arils in syrup a combination of 40 per cent arils and 60 per cent syrup of 75^0B TSS (T_2) was found to be best on the basis some physico-chemical and sensorycharacteristics. This combination obtained maximum scores for sensory parameters, like colour, texture, taste, aroma and overall acceptability which might be due to best combination of arils and syrup and best sugar-acid blend in the product. All these factors might have led the judges to award the highest scores to this combination.

Effect of storage

Physico-chemical characteristics

The colour intensity of arils decreased during storage, the colour of arils changed from red purple 61 (C) to red purple 65 (C) in the both the packaging materials under ambient storage conditions, however, colour of arils changed from red purple 61 (C) to red purple 62 (D) in both the packaging materials under refrigerated conditions. There was a significant decrease in colour intensity during storage of wild pomegranate arils in syrup. More decrease in colour intensity of arils in syrup was recorded under ambient storage conditions as compared to refrigerated conditions. Decrease in colour intensity during storage might be due to degradation of anthocyanins pigment, however, degradation of anthocyanins were induced by light so more loss of colour in ambient conditions. More retention of original colour of arils in syrup packed in glass jar is as a result of slower reaction rate leading to degradation of colour pigment because of slower heat absorption rate of glass than PET. Similar trend of decrease in colour intensity has been reported by Maester *et al.,* (2004) in pomegranate arils in syrup.

A general increase of reducing sugars of arils in syrup during entire storage period (Table 4). The overall effect of storage period (S), storage conditions (V) and packaging materials (T) on reducing sugars content of this product shows that it increased from 36.77 to 41.52 per cent, more (39.73%) reducing sugars content was found in ambient storage conditions than in refrigerated conditions (38.66%) and higher (39.37%) reducing sugars were recorded in the product packed in PET jar and lower (39.02%) in glass jar. During storage of wild pomegranate arils in syrup, there was a gradual increase in reducing sugars . More increase in sugars was found in arils in syrup homogenate under ambient conditions as compared to refrigerated storage conditions. Increase in sugars during storage might be attributed to the hydrolysis of starch into sugars (Heikal *et al.,* 1964) and higher increase in reducing sugars might be due to the inversion of non-reducing sugars into reducing sugars. More increase in sugars might be due to the faster rate of reactions because of high temperature in ambient conditions as compared to refrigerated storage conditions. Similar trend of increase in sugars have been reported by Waskar and Khurdiya (1987) in phalsa syrup and Jadhav *et al.,* (2006) in kokum syrup. As far as the packaging material is concerned, more increase in sugars recorded in arils in syrup packed in PET jar as compared to glass jar might be due to faster rate of chemical reactions in the product packed in PET jar as a result of difference in their thermal conductance properties.

There was a general decrease of ascorbic acid content of arils in syrup during storage (Table 5). The overall effect of storage period (S), storage conditions (V) and packaging materials (T) on ascorbic acid content of arils in syrup shows that it decreased from 8.34 to 4.99 mg/100 g, retain

Table 4: Effect of packaging and storage on reducing sugars (%) of wild pomegranate arils in syrup

V	Ambient storage(Months)			Mean	Refrigerated storage(Months)			Mean
ST	0	3	6		0	3	6	
T_1	36.77	39.73	42.33	39.61	36.77	38.43	40.07	38.42
T_2	36.77	39.93	42.84	39.85	36.77	39.08	40.84	38.90
Mean	36.77	39.83	42.59	39.73	36.77	38.76	40.46	38.66
TxS interaction Table					**$CD_{0.05}$**			
Treatment	0	3	6	Mean	T= 0.11	T×S= 0.15	T= packaging material	
T_1	36.77	39.08	41.20	39.02	S= 0.13	T×V= 0.19	S= Storage period	
T_2	36.77	39.51	41.84	39.37	V= 0.11	S×V= 0.15	V= Storage conditions	
Mean	36.77	39.29	41.52			T×S×V= NS	T_1= Glass jar	
							T_2= PET jar	

Table 5: Effect of packaging and storage on ascorbic acid (mg/100 g) of wild pomegranate arils in syrup

V	Ambient storage(Months)			Mean	Refrigerated storage(Months)			Mean
ST	0	3	6		0	3	6	
T_1	8.34	5.95	4.21	6.17	8.34	6.75	6.02	7.04
T_2	8.34	5.20	3.95	5.83	8.34	6.40	5.75	6.83
Mean	8.34	5.58	4.08	6.00	8.34	6.58	5.89	6.94
TxS interaction Table					**$CD_{0.05}$**			
Treatment	0	3	6	Mean	T= 0.09	T×S= 0.15	T= packaging material	
T_1	8.34	6.35	5.12	6.60	S= 0.11	T×V= NS	S= Storage period	
T_2	8.34	5.80	4.85	6.33	V= 0.09	S×V= 0.15	V= Storage conditions	
Mean	8.34	6.08	4.99			T×S×V= NS	T_1= Glass jar	
							T_2= PET jar	

more (6.94 mg/100 g) in refrigerated conditions as compared to ambient conditions (6.00 mg/100 g), higher (6.60 mg/100 g) and lower (6.33 mg/100 g) ascorbic acid of the product was observed in glass jar and PET jar, respectively.

A continuous decrease was observed in ascorbic acid content of arils in syrup with advancement of storage period. However, decrease was significantly lower under refrigerated conditions than ambient conditions. 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 (2003) in tamarind syrup. Ascorbic acid is highly sensitive to heat, so, its degradation was more in ambient storage conditions. 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 it as glass materials absorb heat slower than PET material.

A general decrease was observed in anthocyanins content during entire storage period (Table 6). The overall effect of storage period (S), storage conditions (V) and packaging materials (T) on anthocyanins content of arils in syrup shows that it decreased from 8.09 to 3.15 mg/100 g, retained more (5.81 mg/100g) in refrigerated conditions than ambient storage conditions (4.88 mg/100 g) and higher (5.49 mg/100 g) anthocyanins content was retained in glass jar and lower in PET jar (5.20 mg/100 g) during storage. A significant decrease in anthocyanins content of arils in syrup was recorded during storage and more retention of anthocyanins was observed under refrigerated storage conditions than ambient conditions. Loss of anthocyanins in arils in syrup might be due to their high susceptibility to auto-oxidative degradation during storage. More retention of this characteristic in the product might be due to slower rate of auto oxidation of anthocyanins in the product in refrigerated storage conditions than ambient conditions. Lower decrease in anthocyanins of arils in syrup packed in glass jar observed during storage might be due to the slower rate of reactions in glass as it absorbs heat at slower rate than PET material.

Table 6: Effect of packaging and storage on anthocyanins (mg/100 g) of wild pomegranate arils in syrup

V	Ambient storage(Months)			Mean	Refrigerated storage(Months)			Mean
ST	0	3	6		0	3	6	
T_1	8.09	4.50	2.60	5.06	8.09	5.62	4.05	5.92
T_2	8.09	4.02	2.00	4.70	8.09	5.06	3.96	5.70
Mean	8.09	4.26	2.30	4.88	8.09	5.34	4.01	5.81
TxS interaction Table					**$CD_{0.05}$**			
Treatment	0	3	6	Mean	T= 0.10	T×S= 0.18	T= packaging material	
T_1	8.09	5.06	3.33	5.49	S= 0.13	T×V= NS	S= Storage period	
T_2	8.09	4.54	2.98	5.20	V= 0.10	S×V= 0.18	V= Storage conditions	
Mean	8.09	4.80	3.15			T×S×V= 0.25	T_1= Glass jar	
							T_2= PET jar	

A general decrease was observed in phenols content of arils in syrup during storage (Table 7). The overall effect of storage period reveals that there was a significant decrease in phenols of this product from 32.91 to 25.73 mg/100 g. The overall effect of storage conditions on phenols of this product reflect that it retained more (29.82 mg/100 g) in refrigerated conditions as compared to ambient storage conditions (27.88 mg/100 g). However, higher (29.28 mg/100 g) phenols content was retained in glass jar and lower in PET jar (28.42 mg/100 g) while comparing overall effect of packaging material (T) on phenols content of this product. A gradual decrease in phenols content of arils in syrup was observed during storage (Table 9) which was less under refrigerated storage conditions than ambient conditions. Significant decrease in phenols content during storage might be due to their involvement in the formation of polymeric compounds by complexing with protein and their subsequent precipitation as observed by Abers and Wrolstad (1979) in strawberry preserve and Premachandran (1982) in apple nectar. Slower rate of loss of phenols might be due to slower reaction rate in refrigerated storage conditions as compared to ambient. However, retention of more phenols of arils in syrup in glass jar may also be due to the slower reaction rate in glass jar, as glass material absorbs heat at slower rate as compared to PET.

Microbiological quality

The total microbial count increased in arils in syrup during entire storage (Table 9. The minimum microbial count of 10 cfu/g was observed in glass jar stored under refrigerated storage conditions after six months. The product packed in PET jar stored under ambient conditions exhibited highest

Table 7. Effect of packaging storage on phenols (as tannic acid mg/100 g) of wild pomegranate arils in syrup

T \ V / S	Ambient storage (Months) 0	3	6	Mean	Refrigerated storage (Months) 0	3	6	Mean
T_1	32.91	27.64	24.45	28.33	32.91	29.56	28.20	30.22
T_2	32.91	26.17	23.22	27.43	32.91	28.32	27.02	29.42
Mean	32.91	26.90	23.84	**27.88**	32.91	28.94	27.61	**29.82**

TxS interaction Table

Treatment	0	3	6	Mean
T_1	32.91	28.60	26.33	**29.28**
T_2	32.91	27.24	25.12	**28.42**
Mean	**32.91**	**27.93**	**25.73**	

$CD_{0.05}$

T= 0.12 T×S= 0.21 T=packaging material
S= 0.15 T×V= NS S=Storage period
V= 0.12 S×V= 0.21 V= Storage conditions
T×S×V= NS T_1= Glass jar
T_2= PET jar

Table 8. Microbial population ($X10^2$ cfu/g) of wild pomegranate arils in syrup

T \ I	Initial	Ambient storage (Months) 3	6	Refrigerated storage (Months) 3	6
T_1	0.00	0.06	0.2	0.03	0.1
T_2	0.00	0.09	0.3	0.06	0.2

T = Treatment T_1 = Glass jar
I = Storage interval T_2 = PET jar

Table 9. Effect of packaging and storage on overall acceptability score of wild pomegranate arils in syrup

V	Ambient storage (Months)			Mean	Refrigerated storage (Months)			Mean
S / T	0	3	6		0	3	6	
T_1	8.25	7.20	6.75	7.40	8.25	7.80	7.05	7.70
T_2	8.25	6.85	6.20	7.10	8.25	7.45	6.80	7.50
Mean	8.25	7.03	6.48	**7.25**	8.25	7.63	6.93	**7.60**

Tx S interaction Table					$CD_{0.05}$		
Treatment	0	3	6	**Mean**	T= 0.06	T×S= 0.10	T= packaging material
T_1	8.25	7.50	6.90	**7.55**	S= 0.07	T×V= NS	S= Storage period
T_2	8.25	7.15	6.50	**7.30**	V= 0.06	S×V= 0.10	V= Storage conditions
Mean	**8.25**	**7.33**	**6.70**			T×S×V= NS	T_1= Glass jar T_2= PET jar

microbial load of 30 cfu/g after six months of storage. Increase in total microbial count (cfu/g) was observed during storage (Table 8) which might be due to contamination during plating instead of contaminated product. The arils in syrup packed in glass jar and stored under refrigerated storage conditions recorded minimum microbial load during storage. Muzzaffar (2007) in pumpkin products and Kaushal (2004) 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.

Sensory characteristics

The overall acceptability scores of wild pomegranate arils in syrup decreased during entire storage period (Table 9). The overall effect of storage period (S), storage conditions (V) and packaging materials (T) on the overall acceptability score of this product shows that score decreased from 8.25 to 6.70, retained higher (7.60) in refrigerated storage conditions and lower (7.25) in ambient storage conditions, whereas, higher (7.55) score of overall acceptability was attained in glass jar and lower (7.30) in PET jar. The overall acceptability scores of arils in syrup decreased significantly during storage. However, the arils in syrup stored at refrigerated storage conditions was significantly better in overall acceptability scores than in ambient conditions. Arils in syrup packed in glass jar retained more overall acceptability scores than PET jar. Decrease in overall acceptability scores might be due to the loss in appearance, flavour compounds and uniformity of the product. Higher overall acceptability scores retained in refrigerated conditions might be due to the minute loss of colour, appearance, texture and flavour compounds during storage. However, the retention of better overall acceptability scores of arils in syrup in glass jar might be due to the better retention of appearance, texture and flavour as a result of slower reaction rate in glass jar as compared to PET.

Conclusion

The arils in syrup product prepared with 40 per cent arils and 60 per cent syrup of 75^0B TSS was found to be the best on the basis of its physico-chemical and 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 bottle in ambient conditions

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